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The High Resolution X-ray (HRX) Detector Development

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During the performance period of this Grant we have carried out the following activities:

- High resolution CCD camera specification and acquisition.
- Design of CCD camera electronics.
- Image acquisition hardware and related software development.

These activities are described in detail below.

1. CCD Camera. The intent of the HRX detector development program is to construct a high resolution imaging detector for soft x-ray and XUV applications, which is suitable for flight in low-cost NASA space programs such as sounding rockets and FastSats. In order to produce a high quality detector at a cost which is 10 to 100 times lower than a typical space-qualified camera of this performance level, we start with a commercially available unit and then introduce whatever modifications are necessary for the camera to be used in a spaceborne application. Typically, the areas which need to be modified have to do with survivability in the launch environment and operation in a vacuum, with the related heat dissipation considerations.

   Following a survey of the commercially available units, we have purchased a 1000X1000 pixel CCD sensor from SITe. This device is backside-thinned, without an anti-reflection coating, so that it is directly sensitive to soft x-ray and XUV photons. The sensor is similar to that flown on the SOHO satellite, for the EIT instrument. However, our device has the standard 24 micron pixel size, which makes control of XUV sensitivity easier.

   The sensor has been delivered and we are currently in the process of evaluating its performance. We are also carrying out structural and thermal analyses to determine what structural modifications will be needed for the camera to survive a typical launch vibration spectrum, and in order to determine whether special measures will be needed to remove heat from any components within the camera head. We are also designing a back-to-back thermoelectric heater/cooler which will be attached to the CCD mount for cooling and heating of the sensor.

2. Camera electronics. We have designed a camera control and readout board for the SITe CCD sensor. The board controls the relevant voltages and timing of clock pulses, as well as integration start and stop times for the CCD. The board is designed to fit into a small area, so that the device can be used in a telescope without excessive obscuration of the imaging optic, or without the need for a large off-axis mounting position.

   The PC board design has been sent (by modem) to a manufacturer for fabrication. When delivered to SAO, the board will be populated and tested, so that image quality tests of the CCD can proceed. These tests will include evaluation of detector readout noise as a function of CCD temperature and pixel readout rate, and a determination of the CCD quantum efficiency as a function of wavelength in the soft x-ray region. Some of these tests will be carried out at Bell Labs, using a calibrated monochromator, so that absolute efficiency as a function of wavelength can be measured.

3. Image acquisition. We have identified a high quality image acquisition board made by Dipix, which can accept 2000X2000 images at over 1 million pixels per second. The board has a high-density 16MB memory and also contains a high-speed digital signal processor. Software development for use of this board with the PXL camera is under way.

   We are also evaluating a lower-cost board manufactured by Matrox. If this board is adequate for reading out the SITe device, it will lower the acquisition cost by 80%.